

**IN THE CLAIMS:**

- 1 1. (Original) A method for defragmenting data blocks on disks of a computer configured  
2 to implement a file system that logically organizes the blocks as a file on the disks, the  
3 file further including indirect blocks having pointers that reference the data blocks, the  
4 method comprising the steps of:  
5       determining a current layout of a range of pointers contained in each indirect  
6 block of the file;  
7       calculating a number of operations needed to retrieve the data blocks referenced  
8 by the pointers from the disks to a memory of the computer;  
9       estimating a potential new layout based on an average fullness of the file system;  
10 and  
11       relocating the data blocks on the disks if the potential new layout improves the  
12 current layout.
- 1 2. (Original) The method of Claim 1 wherein the step of relocating comprises the step of  
2 relocating the data blocks if there is sufficient free space on the disks.
- 1 3. (Original) The method of Claim 2 wherein the step of relocating comprises the steps of  
2 loading the data blocks into the memory of the computer and dirtying the data blocks.
- 1 4. (Original) The method of Claim 3 wherein the step of relocating further comprises the  
2 steps of:  
3       searching a predetermined distance of a first disk for free blocks; and  
4       filling those free blocks with the dirtied data blocks.

1 5. (Original) The method of Claim 4 wherein the step of relocating further comprises the  
2 steps of:

3 jumping to a second disk;

4 searching the predetermined distance of the second disk for additional free blocks;

5 and

6 filling those additional free blocks with the dirtied data blocks.

1 6. (Original) The method of Claim 5 wherein the step of relocating further comprises the  
2 step of repeating the steps of jumping, searching and filling until all data blocks of the  
3 file have been relocated.

1 7. (Original) The method of Claim 5 wherein the predetermined distance is 32 data  
2 blocks.

1 8. (Original) A system adapted to defragment data blocks on disks of a computer config-  
2 ured to implement a file system that logically organizes the blocks as a file on the disks,  
3 the file further including indirect blocks having pointers that reference the data blocks,  
4 the system comprising:

5 a processor coupled to the disks;

6 a memory coupled to the processor and having locations addressable by the proc-  
7 essor; and

8 a storage operating system resident in the memory locations and executed by the  
9 processor to invoke storage operations in support of the file system, the storage operating  
10 system including a scanner adapted to (i) determine a current layout of a range of pointers  
11 contained in each indirect block of the file, (ii) calculate a number of operations needed  
12 to retrieve the data blocks referencing the pointers from the disks to the memory and (iii)  
13 estimate a potential new layout based on an average fullness of the file system, the stor-  
14 age operating system further including a write allocator adapted to relocate the data

15 blocks on the disks if the potential new layout improves fragmentation of the current lay-  
16 out.

1 9. (Original) The system of Claim 8 wherein the file system is a write anywhere file sys-  
2 tem.

1 10. (Original) The system of Claim 9 wherein the scanner comprises a defragmentation  
2 process.

1 11. (Original) The system of Claim 10 wherein the range of pointers is a number of data  
2 blocks referenced by the pointers of an indirect block.

1 12. (Original) The system of Claim 11 wherein the number of data blocks referenced by  
2 the pointers of an indirect block is 1024.

1 13. (Original) The system of Claim 8 wherein the memory is a buffer cache.

1 14. (Currently Amended) A method for defragmenting data blocks on disks of a computer  
2 configured to implement a file system that logically organizes the blocks as a file on the  
3 disks, the file further including indirect blocks having pointers that reference the data  
4 blocks, the method comprising the steps of:  
5       locating a beginning of the file;  
6       selecting a range of data blocks to defragment, where the range of data blocks is a  
7 number of blocks referenced by an indirect block;  
8       attempting defragmentation of the range of data blocks by determining whether a  
9 new layout is better than an existing layout; and  
10       repeating the steps of selecting and attempting until defragmentation of all ranges  
11 of data blocks within the file has been attempted.

1 15. (Canceled)

1 16. (Currently Amended) The method of Claim ~~15~~ 14 wherein the number of blocks is  
2 1024 blocks.

1 17. (Currently Amended) ~~The Method of claim 14 wherein the step of attempting com-~~  
2 ~~prises the steps of:~~ A method for defragmenting data blocks on disks of a computer con-  
3 figured to implement a file system that logically organizes the blocks as a file on the  
4 disks, the file further including indirect blocks having pointers that reference the data  
5 blocks, the method comprising the steps of:  
6 locating a beginning of the file;  
7 selecting a range of data blocks to defragment, where the range of data blocks is a  
8 number of blocks referenced by an indirect block;  
9 attempting defragmentation of the range of data blocks comprising,  
10 reading pointers for the range of data blocks,  
11 measuring an existing layout of the range of data blocks,  
12 estimating a new layout of the range of data blocks,  
13 determining whether the new layout is better than the existing layout,  
14 if the new layout is better, determining whether there is sufficient free  
15 space in the file system to relocate the data blocks,  
16 if there is sufficient free space, reading the data blocks into a buffer cache  
17 and dirtying the data blocks, and  
18 rewriting the dirtied data blocks to new locations on the disks; and  
19 repeating the steps of selecting and attempting until defragmentation of all ranges  
20 of data blocks within the file has been attempted.

1 18. (Original) The method of Claim 17 wherein the step of measuring comprises the step  
2 of calculating a number of write\_alloc\_chunks needed to cover the data blocks in the  
3 range.

1 19. (Original) The method of Claim 18 wherein the number of write\_alloc\_chunks ranges  
2 from a number of data blocks in the range and a number of data blocks in the range di-  
3 vided by a write\_alloc\_chunk.

1 20. (Original) The method of Claim 18 wherein the step of estimating comprises the step  
2 of estimating the new layout using an average fullness of the file system.

1 21. (Original) The method of Claim 18 wherein the step of determining whether the new  
2 layout is better than the existing layout comprises the step of comparing existing and es-  
3 timated numbers of write\_alloc\_chunks.

1 22. (Original) Apparatus for defragmenting data blocks on disks of a computer config-  
2 ured to implement a file system that logically organizes the blocks as a file on the disks,  
3 the file further including indirect blocks having pointers that reference the data blocks,  
4 the apparatus comprising:

5 means for determining a current layout of a range of pointers contained in each  
6 indirect block of the file;

7 means for calculating a number of operations needed to retrieve the data blocks  
8 referenced by the pointers from the disks to a memory of the computer;

9 means for estimating a potential new layout based on an average fullness of the  
10 file system; and

11 means for relocating the data blocks on the disks if the potential new layout im-  
12 proves the current layout.

1 23. (Original) The apparatus of Claim 22 wherein the means for relocating comprises:  
2 means for searching a predetermined distance of the disks for free blocks; and  
3 means for filling the free blocks with the data blocks.

1 24. (Original) A computer readable medium containing executable program instructions  
2 for defragmenting data blocks on disks of a computer configured to implement a file  
3 system that logically organizes the blocks as a file on the disks, the file further including  
4 indirect blocks having pointers that reference the data blocks, the executable program in-  
5 structions comprising program instructions for:  
6 determining a current layout of a range of pointers contained in each indirect  
7 block of the file;  
8 calculating a number of operations needed to retrieve the data blocks referenced  
9 by the pointers from the disks to a memory of the computer;  
10 estimating a potential new layout based on an average fullness of the file system;  
11 and  
12 relocating the data blocks on the disks if the potential new layout improves the  
13 current layout.

1 25. (Original) The computer readable medium of Claim 24 wherein the program instruc-  
2 tion for relocating comprises program instructions for:  
3 searching a predetermined distance of the disks for free blocks; and  
4 filling the free blocks with the data blocks.

Please add New Claims 26 *et seq.*

1 26. (New) Electromagnetic signals propagating on a computer network, comprising:  
2 said electromagnetic signals carrying instructions for execution on a processor for  
3 the practice of the method of,

4           determining a current layout of a range of pointers contained in each indirect  
5 block of the file;  
6           calculating a number of operations needed to retrieve the data blocks referenced  
7 by the pointers from the disks to a memory of the computer;  
8           estimating a potential new layout based on an average fullness of the file system;  
9 and  
10          relocating the data blocks on the disks if the potential new layout improves the  
11 current layout.

1 27. (New) A method for defragmenting data blocks on disks of a computer configured to  
2 implement a file system that logically organizes the blocks as a file on the disks, com-  
3 prising:

4           determining a current layout of the data blocks on the disks, and determining a  
5 fragmentation of the current layout;  
6           estimating a fragmentation of a potential new layout of the data blocks on the  
7 disks; and  
8           relocating the data blocks on the disks if the potential new layout has less frag-  
9 mentation then the current layout.

1 28. (New) The method as set forth in claim 27, further comprising:

2           referencing the data blocks on the disks by of at least one indirect block having at  
3 least one pointer.

1 29. (New) The method as set forth in claim 27, further comprising:

2           referencing the data blocks on the disks by an indirect block containing a plurality  
3 of pointers.

1 30. (New) The method as set forth in claim 27, further comprising:  
2       referencing the data blocks on the disks by a plurality of indirect blocks having a  
3 plurality of pointers.

1 31. (New) A system adapted to defragment data blocks on disks of a computer config-  
2 ured to implement a file system that logically organizes the blocks as a file on the disks,  
3 comprising:

4       a scanner to determine a current layout of the data blocks on the disks, and to es-  
5 timate a potential new layout of the data blocks on the disks; and

6       a write allocator to relocate the data blocks on the disks if the potential new layout  
7 improves fragmentation of the current layout.

1 32. (New) The system as set forth in claim 31, further comprising:

2       the data blocks on the disks are made up of a plurality of indirect blocks having a  
3 plurality of pointers.

1 33. (New) An apparatus for defragmenting data blocks on disks of a computer config-  
2 ured to implement a file system that logically organizes the blocks as a file on the disks,  
3 comprising:

4       means for determining a current layout of the data blocks on the disks, a frag-  
5 mentation of the current layout;

6       means for estimating a fragmentation of a potential new layout of the data blocks  
7 on the disks; and

8       means for relocating the data blocks on the disks if the potential new layout has  
9 less fragmentation than the current layout.



1 34. (New) The apparatus as set forth in claim 33, further comprising:  
2 means for referencing the data blocks on the disks by of at least one indirect block  
3 having at least one pointer.

1 35. (New) The apparatus as set forth in claim 33 further comprising:  
2 means for referencing the data blocks on the disks by an indirect block containing  
3 a plurality of pointers.

1 36. (New) The apparatus as set forth in claim 33, further comprising:  
2 means for referencing the data blocks on the disks by a plurality of indirect blocks  
3 having a plurality of pointers.

1 37. (New) A computer readable medium containing executable program instructions for  
2 defragmenting data blocks on disks of a computer configured to implement a file system  
3 that logically organizes the blocks as a file on the disks, the executable program instruc-  
4 tions comprising program instructions for:  
5 determining a current layout of the data blocks on the disks, and determining a  
6 fragmentation of the current layout;  
7 estimating a fragmentation of a potential new layout of the data blocks on the  
8 disks; and  
9 relocating the data blocks on the disks if the potential new layout has less frag-  
10 mentation then the current layout.

1 38. (New) Electromagnetic signals propagating on a computer network, comprising:  
2 said electromagnetic signals carrying instructions for execution on a processor for  
3 the practice of the method of,  
4 determining a current layout of the data blocks on the disks, and determining a  
5 fragmentation of the current layout;

- 6           estimating a fragmentation of a potential new layout of the data blocks on the
- 7   disks; and
- 8           relocating the data blocks on the disks if the potential new layout has less frag-
- 9   mentation then the current layout.